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ABSTRACT

This guide contains teacher background information and activities for students that relate to space travel and is designed to encourage elementary school students to take a greater interest in mathematics and science. The activities in this guide are to be used with grades 1 to 3 and cover the topics of food, clothing, health, housing, communication, and working in space. Each section includes background information; a teacher printout listing objectives, vocabulary, motivation, and activity descriptions; and extensive student worksheets. A list of National Aeronautics and Space Administration Resource Centers concludes the guide. (TW)

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LIVING IN SPACE

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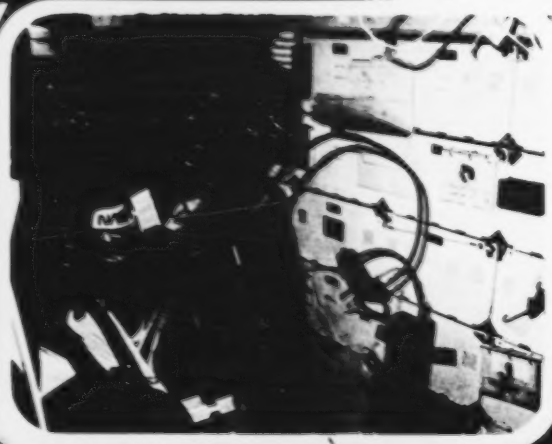

SE 048 878

OPERATION LIFTOFF

Elementary Space Program

A Resource Guide With Activities
For Elementary School Teachers

BOOK I

Levels A, B, and C for grades 1, 2, 3

- FOOD
- HOUSING
- CLOTHING
- COMMUNICATION
- HEALTH
- WORKING

LIVING IN SPACE

OPERATION LIFTOFF

Elementary School Space Program

LIVING IN SPACE

BOOK I

Levels A, B, C

Authors: Sheila Briskin Andrews
Audrey Kirschenbaum
Illustrator: Arline Lowe

Books in this Series

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Astronomy
Space Transportation
Space Futures

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LIVING IN SPACE

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INTRODUCTION

In June 1984 President Reagan announced a new NASA education program, "Operation Liftoff": "For more than 25 years NASA has pioneered on the cutting edge of science and technology and has stimulated our young people to strive for excellence in all they do." This program is designed to encourage pupils in the nation's elementary schools to take a greater interest in mathematics and science.

NASA responded to this announcement with a plan to reach students in their formative years in the elementary grades. Operation Liftoff complements the widely acclaimed educational programs NASA now offers at the secondary and university levels.

To support this project, NASA is developing new educational products which utilize the latest in educational technology. These include not only publications and videotape packages, but computer software and laser disc products. A Teacher Resource Center has been established at each NASA Center, where teachers can copy the aerospace materials to enhance their teaching of aerospace concepts.

NASA is deeply indebted to these people who contributed to the success of this project: Deborah Rivera, Project Officer for Operation Liftoff, overall coordinator for this project; Larry B. Bilbrough and Muriel M. Thorne, NASA Educational Programs Officers; Dr. Harry B. Herzer, III, Dr. Doris K. Grigsby and Clarice F. Lolich, NASA Aerospace Education Program Specialists; and Pamela M. Bacon and Katherine S. Forsythe, educational consultants to NASA.

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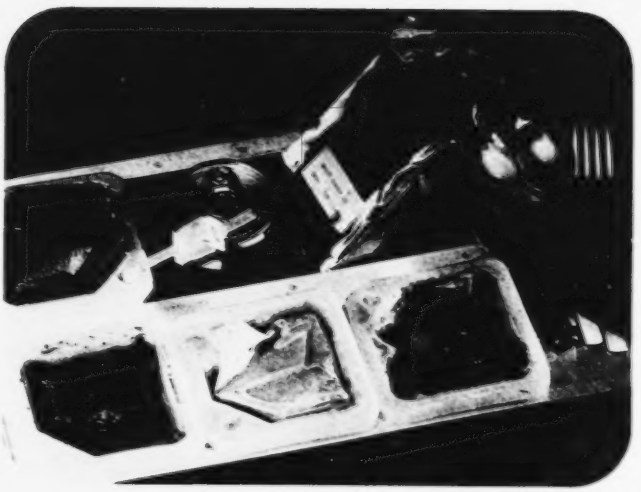
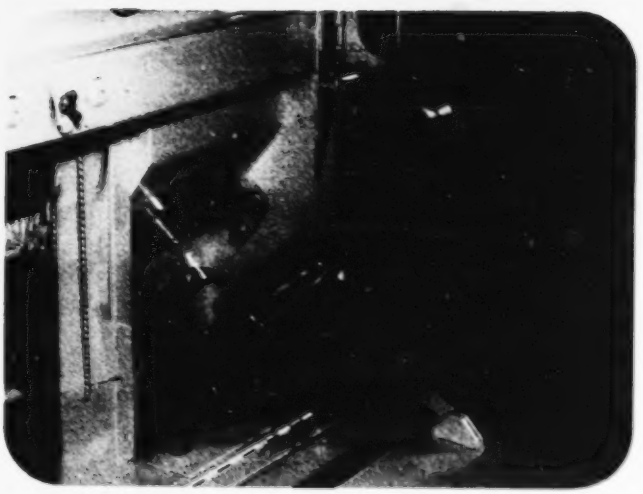
Secondary Programs Branch
National Aeronautics and
Space Administration
Washington, DC

F O O D

BOOK I

LIVING IN SPACE





BACKGROUND INFORMATION

Concepts

Eating is essential to survival. The food astronauts take into space must

- be lightweight
- require little storage space
- be nutritious
- be convenient to use
- need no refrigeration

Dehydrated Foods for Space Travel

Foods are dehydrated to meet weight restrictions for the Space Shuttle liftoff. They are later rehydrated in orbit when they are ready to be eaten. Water used for rehydration comes from the Shuttle's fuel cells. The fuel cells produce electricity by combining hydrogen and oxygen, resulting in water. Since water is an available by-product from the fuel cells, it is possible to send food in a dried form for later rehydration.

More than a hundred different food items, such as cereals, spaghetti, scrambled eggs, and strawberries, go through this dehydration/rehydration process. When a strawberry is freeze-dried, it remains full-size in outline, with its color, texture, and quality intact. It can be rehydrated with saliva as it is chewed or by adding water to the package.

Twenty varieties of drinks, including tea and coffee, are also dehydrated for use in space travel. But pure orange juice or whole milk cannot be included. If water is added to dehydrated orange crystals, there is no rehydration mixture — just orange "rocks" in water. If whole milk is rehydrated, the dried milk does not dissolve properly. It floats around in lumps and has a disagreeable taste. So skim milk must be used. Back in the 1960s, General Foods developed a synthetic orange juice product called Tang, which could be used in place of orange juice.

Other Foods for Space Travel

Shuttle food items are brought aboard in several different forms:

Natural form

Examples are graham crackers, pecan cookies, peanut butter, hard candy, gum.

Thermostabilized

Cooked at moderate temperatures and sealed in cans. Examples are tuna fish, canned fruit in heavy syrup.

Irradiated

Preserved by exposure to ionizing radiation. Examples are meat and bread.

Intermediate moisture process

Removing part of the water. Examples are dried apricots, peaches, pears.

Salt and pepper are packaged in liquid form because crystals would float around the cabin.

You may want to mention that tobacco and liquor are barred from the Shuttle.

Packaging Food for Space

All food in space must be packaged in individual serving portions that allow easy manipulation in the weightless environment of an orbiting spacecraft. Packages can be off-the-shelf thermostabilized cans, flexible pouches, or semirigid containers.

Food Preparation

The variety of food carried into orbit is so broad that crew members enjoy a six-day menu cycle. A typical dinner might consist of a shrimp cocktail, steak, broccoli, rice, fruit cocktail, chocolate pudding, and grape drink. To prepare the meal, the mission specialist chef takes a big plastic overwrap out of the food locker. The package is attached to a worktable. Inside the overwrap are four smaller plastic overwraps, each holding a complete meal of seven separate containers. Using a hollow needle attached to the hot water outlet, the chef injects a prescribed amount of water through a narrow passageway into the plastic bowls of dehydrated broccoli and rice.

The chef kneads the packages through their flexible plastic tops and secures them in the oven along with the four precooked steaks. The steaks are packaged in flexible aluminum-backed plastic bags, called flex-pouches. The heat in the oven is 82° C, which does not harm the plastic containers. A fan circulates air so that the food is heated evenly.

While these items warm in the oven, the mission specialist takes four trays from the galley and attaches them by magnets or clamps to a portable dining table hooked to the lockers. The mission specialist then adds cold water through the hollow needle to rehydrate the bowls of shrimp, chocolate pudding, and grape drink. A plastic straw with a clamp on it is inserted into the passageway of the grape drink. These cold items, along with the cans of fruit cocktail, the silverware, and a can opener, are assembled on the trays and held by magnets or Velcro tape. When the heated foods are ready, it is dinner time.

TEACHER PRINTOUT

Objectives

Students will understand the following:

- Astronauts need food to survive.
- Astronauts must bring their food into space.
- Food is dehydrated because of limited space.

Vocabulary

Have the students use these words as part of your motivating discussion and in the follow-up *Space Lab* and *Space Countdown* activities.

- A-OK (Everything is fine!)
- milliliter (one thousandth of a liter)
- gram (one thousandth of a kilogram)
- astronaut
- spacecraft
- dehydrated
- graph

Motivation

1. **Astronauts must eat balanced meals. If you were an astronaut, what foods would you take with you on a space flight?**

(Accept any answers that are food related. Possible answers: granola bars, Tang, powdered milk, beef jerky, apples, bread, or dehydrated vegetables, fish, and meat).

2. **To keep your body healthy, you need a variety of foods each day. What are the four food groups?**

(Meat, dairy, fruits and vegetables, bread and cereals.) Relate answers from question 1 to these four food groups.

3. **Bring in pieces of dehydrated fruit, such as apples or banana chips for the students to taste. Explain the process of dehydration. Ask: What are some foods at home that are dehydrated?**

(Possible answers: Dehydrated pieces in packaged soups, such as mushrooms, chicken, parsley, green peppers, carrots. Dehydrated spices such as parsley and onions.)

Activity Description

The *Student Liftoff* page for this lesson contains two activities: *Space Lab* and *Space Countdown*.

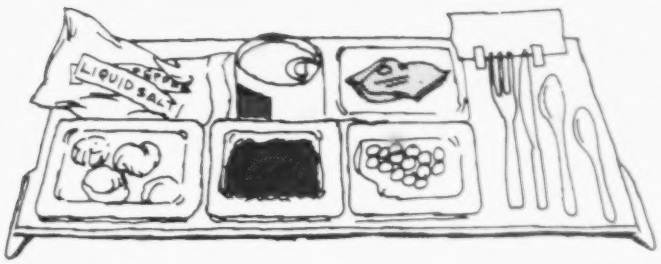
The *Space Lab* is a hands-on experiment in which students learn about rehydrating a food product. The students are asked: How is water put back into food? The experiment simulates rehydrating by reconstituting an orange drink. This activity may be done at school or at home.

The *Space Countdown*, a math activity, requires the student to count, read a graph, and compare quantities of most and least.

Additional Activities for School or Home

- Make instant pudding. Pour some pudding into a plastic Ziploc sandwich bag. Close the bag. Cut off the tip of the bag and have the students eat pudding by squeezing it out through the hole. This experiment shows how astronauts ate on early space flights.
- Create a class poem or story in which the students imagine being orange juice drink crystals (dehydrated form) and changing into a liquid orange drink (rehydrated form). This writing activity can be illustrated. Have each child list dehydrated foods found at home. Record the results as a class graph.
- Plan a tasting party with samples representing each of the different types of food taken on a Space Shuttle mission – rehydratable, thermostabilized, intermediate moisture, irradiated, and natural form.

STUDENT LIFTOFF



Astronauts need food, even in space. But a spacecraft has little room to store food.

Scientists take water out of some foods. Then the food takes up less room.

The water is put back into the food at mealtime.

The food looks good and tastes good. Mealtime in space is A-OK.

Space Lab

How is water put back into food?

You need: 15 grams of orange drink crystals, 200 milliliters of cold water, 1 glass, 1 spoon, 1 straw.

Step 1. Measure 15 grams of orange drink crystals into a glass.

Step 2. Add 200 milliliters of cold water.

Step 3. Mix well with a spoon.

Step 4. Drink with a straw.

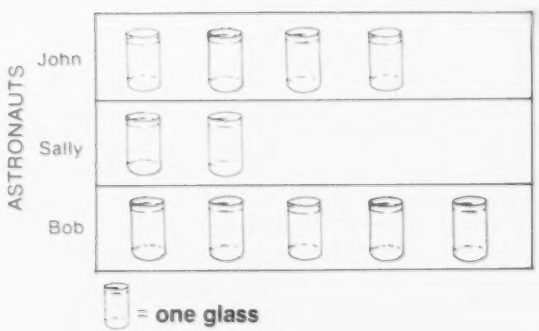
Look at the orange drink crystals.
Look at the water.
How have the crystals changed?
How has the water changed?

Space Countdown

Look at the graph. It shows how many glasses of orange drink each astronaut had.

Use the graph to answer the questions.

1. Which astronaut drank the most?
2. Which astronaut drank the least?
3. How many glasses of orange drink did they have altogether?



TEACHER PRINTOUT

FOOD
LIVING IN SPACE

Objectives

Students will understand the following:

- Food must be lightweight to meet Shuttle liftoff restrictions.
- Food needs to be compactly packaged to meet storage limitations.
- Dehydrated food meets the special requirements for space flight.
- Dehydrated food is rehydrated before it is eaten.

Vocabulary

Have the students use these words as part of your motivating discussion and in the follow-up *Space Lab* and *Space Countdown* activities.

- astronaut
- spacecraft
- lightweight
- dehydration
- balance scale

Motivation

1. What's in your lunch box today?

(Accept any food answers.)

2. If you had to fit food for seven days into your lunch box, what would you do?

(Accept any logical answers.)

3. Ask the students to predict what an astronaut might eat in space. Relate to question 2, explaining that food for several days must fit in a small space.

(Accept any food answers, listing them on the board. After reading the text, have children decide which of the suggested foods could be dehydrated and taken aboard the Shuttle. Use background information to discuss other food forms.)

Activity Description

The *Student Liftoff* page for this lesson contains two activities: *Space Lab* and *Space Countdown*.

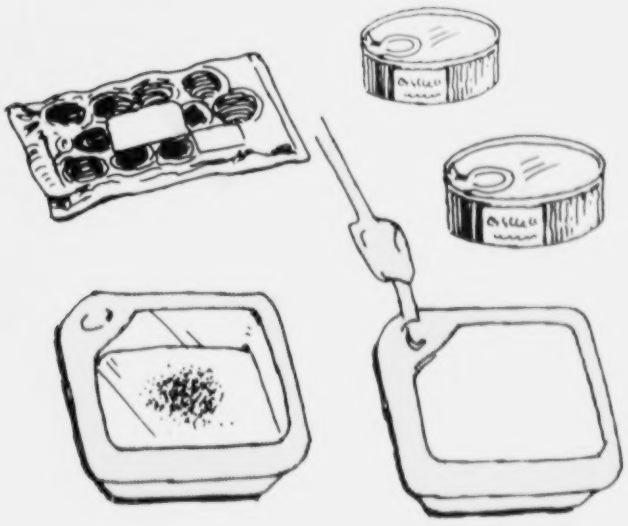
The *Space Lab* experiment with a dried apple gives students a hands-on experience with dehydrating a familiar food. The students are asked: Why does a dried apple take up less room than a fresh apple? The experiment compares a natural-form apple and dried apple slices. This activity may be done at school or at home. The dehydration of other locally available fruits, such as pears, peaches, or papayas could be an extension of this activity.

The *Space Countdown*, a math activity, requires the use of a scale to weigh a fresh apple and six dried apple slices. The activity requires subtraction and involves comparing the concepts of more and less.

Additional Activities for School or Home

- The teacher can make use of the background information provided here to discuss food preservation methods used on Space Shuttle flights. Then organize a trading party. Have students bring two samples of foods preserved in different ways — dried, dehydrated, salted, or smoked. Provide five minutes for students to trade foods. Compare and contrast different methods of preserving food. Complete this activity with a food-tasting party.
- Have students collect pictures illustrating foods that do not need refrigeration. Categorize according to method of preservation. Then use the pictures to create collages for display.
- This activity can be used to simulate the foods eaten by astronauts on early space flights. Have the students bring cooked vegetables to class. For example, steamed yams, carrots, white potatoes, squash, green beans. Puree foods individually in a blender, then seal in plastic Ziploc sandwich bags. Eat the food as astronauts did on early space flights. Clip a small hole in one corner of the bag. Squeeze the food into your mouth.

STUDENT LIFTOFF



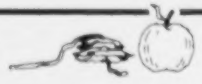
What is in an astronaut's lunch box?
Food that is packaged to take up little room.
Food that is lightweight. Why?
Because a spacecraft cannot carry extra weight.

Water is taken out of food.
Then the food weighs less.
This is called dehydration.

When it is time to eat, water is put back into the food.
A long, thin tool is used to add water to the package.
Then the food tastes and looks like the food you eat.
Astronauts enjoy their meals in space.

Space Lab

Why does a dried apple take up less room than a fresh apple?



You need: 2 apples, a knife, a large-eyed needle, a 30-centimeter piece of yarn.

Step 1. Put an apple in a cool place. Peel and cut the other apple into 6 round slices.

Step 2. Push the threaded needle through each apple piece.

Step 3. Hang the pieces to dry. Check them each day.

Step 4. Place the whole apple next to the pile of dried apple slices. Compare the whole apple with the dried apple slices. Which takes up less room? Why?

Space Countdown

Use the scale in your classroom.
Weigh a whole apple. Write its weight here. _____
Weigh the six dried apple slices from the Space Lab experiment. Write their weight here. _____
Which weighs more? Why? Subtract the weight of the dried slices from the weight of the whole apple. What is the difference?

TEACHER PRINTOUT

FOOD
LIVING IN SPACE

Objectives

Students will understand the following:

- Mission specialists prepare food for the entire crew.
- Food requires special preparation according to form.
- Food eaten during a mission is similar to food eaten on Earth.

Vocabulary

Have the students use these words as part of your motivating discussion and in the follow-up *Space Lab* and *Space Countdown* activities.

- food locker (place to store food aboard the Space Shuttle)
- Velcro (self-gripping fastener with meshing plastic ridges)
- milliliter (one thousandth of a liter)
- mission specialist
- rehydrated
- magnet
- liquified

Motivation

1. What kinds of food might your family take on a camping trip if no cooler was available?

(Foods that do not need refrigeration, such as canned foods, dried foods, cereals, crackers, bread.)

2. Who would prepare the food?

(Any member of the family who likes to cook.)

3. In what ways would camping foods and space flight foods be similar?

(Both would be lightweight, compact for limited storage space, and have no need for refrigeration.)

4. Who would prepare the food?

(A cook or each astronaut.)

Activity Description

The *Student Liftoff* page for this lesson contains two activities: *Space Lab* and *Space Countdown*.

The *Space Lab* is a hands-on experiment comparing the weight of dehydrated with rehydrated foods. The student are asked: How does rehydrating food make it weigh more? The students then rehydrate oatmeal. This experiment shows how rehydrated food has more weight and volume than dehydrated food. This activity may be done at school or at home.

The *Space Countdown*, a math activity, requires the student to read a clock, add time, and subtract time. Students will also need to know the difference between a.m. and p.m.

Additional Activities for School or Home

- Have students bring to class some of the fruit from commercial cereals that contain freeze-dried fruit. Weigh the fruit before placing it in a small bowl with a small measured amount of water. Wait a few minutes and measure the water again. Weigh the fruit after rehydration. Observe what happens to the water and to the fruit. Is the fruit still as hard as when it was first placed into the bowl of water? Explain what happened.

- Have each student imagine he or she is a mission specialist chef aboard the Space Shuttle. Have each student write a letter to someone back on Earth detailing the job. Include some unusual event or problem that occurs. How do these mission specialists meet the challenge?

STUDENT LIFTOFF

Would you like to be the chef on a space mission? Today's menu is shrimp cocktail, steak, broccoli, rice, grape drink, chocolate pudding, and fruit cocktail.

A mission specialist chef prepares this meal in about thirty minutes. The chef removes a complete meal package from the food locker. Food that needs water is rehydrated. Other foods are heated in the oven.

When everything is ready, the food is arranged on trays held in place by Velcro or magnets. The crew season their food with mustard, catsup, or liquified salt and pepper. It's time to dig in!

Space Lab

You will need an adult to help you with this experiment.
How does rehydrating food make it weigh more?

You need: 2 packages of instant oatmeal, 150 milliliters of boiling water, 2 bowls, a spoon.

Step 1. Put 1 package of instant oatmeal into each bowl.

Step 2. Pour boiling water into 1 bowl of oatmeal. Mix well with a spoon.

Step 3. Lift the bowl with dry cereal. Lift the bowl with mixed cereal. Which weighs more? Why?

How does adding water to food change the weight of the food?

Space Countdown

A mission specialist prepares a meal in thirty minutes.

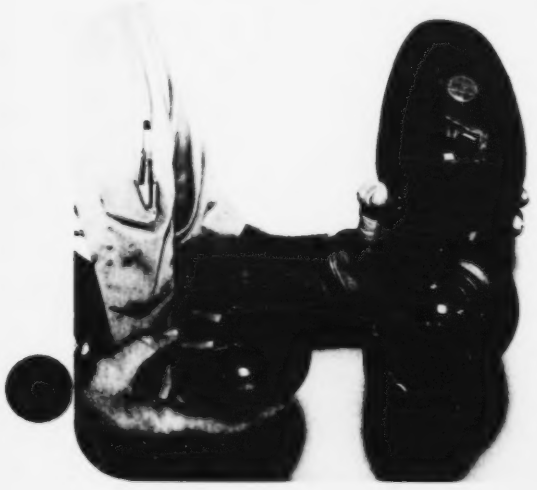
Answer the following questions:

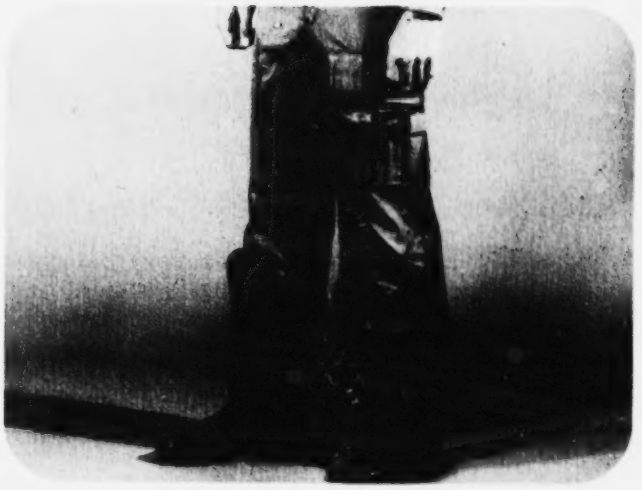
1. Breakfast is at 7:30 a.m. When will the mission specialist start the preparations?
2. If lunch is started at 11:45 a.m., when will the crew eat?
3. Dinner is taken out of storage at 5:15 p.m. When will the astronauts eat?
4. How many hours are there between breakfast and lunch? Between lunch and dinner?

CLOTHING

BOOK I

LIVING IN SPACE





BACKGROUND INFORMATION

Concepts

Aboard the spacecraft, astronauts can work in flight suits that resemble the clothes we wear on earth. Flight suits worn on the Space Shuttle must

- be safe
- be functional
- be comfortable
- be good-looking

Appearance of Clothing Worn for Space Travel

Cobalt blue flight suits, consisting of soft cotton pants and a lined zipper jacket, are issued to each crew member. A navy blue cotton knit short-sleeve shirt coordinates with these outfits. These items are stocked in standard sizes, along with underwear, socks, footwear, and gloves. The astronauts are fitted "off the racks" at NASA's Johnson Space Center near Houston. All clothing, except underwear, is the same for both sexes.

The waist-length jacket is fitted by chest size and sleeve length. Expansion pleats in the shoulders and back make it easier to move and flex while wearing the jacket. The pleats are also needed to compensate for the lack of gravity in space. Without gravity pulling down on an astronaut's body, an astronaut becomes two to five centimeters taller in space. The pleats provide room for this expansion. Flight suit pants are fitted by waist and inseam measurements.

Functional Clothing

Astronauts wear different clothes at different times during the mission. During liftoff, special communications headgear and helmets are added to their flight suits. They also wear a separate backpack that contains an oxygen supply.

Astronauts also put on special gear for atmospheric entry. In addition to the communications headgear and helmets, antigravity suits are worn. The antigravity suit is really an inflatable pair of pants that is put on over underwear. The suit has a valve that is used to fill the suit with oxygen from a bottle. Without the antigravity suit, blood would pool (collect) in the lower part of an astronaut's body. This is caused by the change from weightlessness to the pull of Earth's gravity. This pooling of blood could cause fainting. The pressure exerted by the inflated antigravity suit on the legs and abdomen prevents the pooling of blood.

Safe and Convenient Clothing

The flight suits have built-in safety features. The material is treated with a chemical soak to make it fireproof. The clothing is designed to be loose enough for comfort, without being sloppy. Clothing that is too loose can accidentally turn critical switches on or off by brushing up against them.

A dozen pockets cover much of the flight suit's exterior for storing small useful items. The pockets are closed with either Velcro or zippers. Small items are thereby prevented from sailing about dangerously in the weightless environment of space. Stocked in specific pockets before the flight are felt-tip and pressurized ball-point pens, mechanical pencils, data books, sunglasses, a multipurpose Swiss army pocket knife, and standard surgical scissors.

Clothing Inventory

In-flight clothing consists of

jacket
1 per flight

trousers
1 pair per seven days
1 spare pair per flight

shirt
1 per 3 days

underwear
1 set per day

one-g (gravity) footwear
1 pair per flight

in-flight footwear
1 pair per flight

gloves
1 pair per flight

Each astronaut also has a chronograph watch as well as a sleeping mask and earplugs to help block out Shuttle cabin noises.

TEACHER PRINTOUT

Objectives

Students will understand the following:

- Astronauts work in flight suits aboard the spacecraft.
- Flight suits are jackets, pants, and shirts made of blue cotton.
- Flight suits are similar to clothes worn on Earth.

Vocabulary

Have the students use these words as part of your motivating discussion and in the follow-up *Space Lab* and *Space Countdown* activities.

- Space Shuttle (a reusable spacecraft)
- space suit (protective layers of clothing worn outside the spacecraft)
- astronaut
- flight suit

Motivation

1. What would you wear inside the Space Shuttle on a trip into space?

(Accept any answer that is clothing related. List answers on board.)

2. What type of clothing should an astronaut wear to be comfortable?

(Clothing that is lightweight, made of natural fibers, and resembles the clothing we all wear on Earth.)

Activity Description

The *Student Liftoff* page for this lesson contains two activities: *Space Lab* and *Space Countdown.*

The *Space Lab* is a hands-on experiment that allows students to simulate an astronaut's use of a flight suit. The students are asked: Why do astronauts have many pockets on their flight suits? The students place items in different pockets and retrieve them when asked by a friend. This activity may be done at school or at home.

The *Space Countdown,* a math activity, requires a student to read a graph. This involves counting, subtracting, and comparing.

Additional Activities for School or Home

- Collect different kinds of bags, such as paper lunch bags, paper supermarket bags, plastic sandwich bags, plastic shopping bags, canvas carrying bags. Have the students **predict** which bags will tear most easily, which will be the strongest. List the different kinds of bags in order from weakest to strongest. **Experiment** with tearing each different kind of bag. **Observe** what happens. **Compare** the results with the earlier predictions. Correlate the results of this activity with the kind of testing scientists must do to develop strong, tear-proof materials for astronaut flight suits.

- Have students pretend they are a pen inside an astronaut's pocket. How can they help the astronaut? When will the astronaut use the pen? What might the astronaut write about in a logbook (a book that is used to record events on a flight)? Brainstorm words and ideas with the students. List all suggestions on the board. Accept all suggestions as valid. Use their ideas to create a class experience chart story.

STUDENT LIFTOFF

What does an astronaut wear inside the Space Shuttle?
An astronaut wears a flight suit.

A flight suit is a light blue jacket and pants.
The jacket closes with a zipper.
The jacket and pants have many pockets that hold small tools.
The suit also has a navy blue cotton knit short-sleeve shirt.

Flight suits are comfortable and look nice.
They look like your clothes.

Space Lab

Why do astronauts have many pockets on their flight suits?

You need: a pen, a pencil, eyeglasses, scissors, 1 pair of jeans or overalls with 4 or more pockets.

Step 1. Put on jeans.

Step 2. Fill each pocket with one thing, such as a pen. Think about where each thing is.

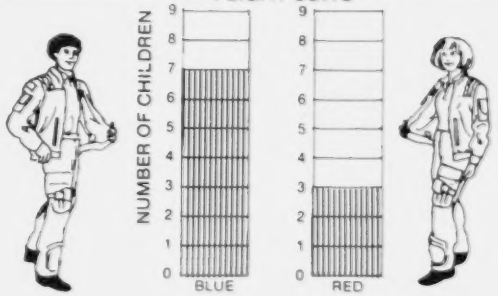
Step 3. As a friend calls out each thing, take it out of its pocket.

Repeat steps 2 and 3.
Can you find things faster each time you try? Why?
How do astronauts use the pockets on their flight suits?

Space Countdown

Some children like the flight suit to be blue.
Other children want the suit to be red.
Look at the graph. Answer the questions.

1. How many children like the blue flight suit?
2. How many children want a red flight suit?
3. How many more children like blue than red?



TEACHER PRINTOUT

Objectives

Students will understand the following:

- Flight suits are designed with safety features.
- Flight suits consist of a soft blue cotton jacket, pants, and shirt.
- Flight suits are fireproof.
- Flight suits have many pockets for holding small items.

Vocabulary

Have the students use these words as part of your motivating discussion and in the follow-up *Space Lab* and *Space Countdown* activities.

- fireproof (treated with chemicals to retard flames)
- Velcro (self-tightening fastener with meshing plastic ridges)
- flight suit
- switch
- accident
- astronaut
- comfortable
- graph

Motivation

1. What makes clothing safe?

(Materials can be treated with flame-retardant chemicals. Relate answers to the flame-retardant materials used in children's pajamas. Clothes should fit properly; for example, children would not wear loose-fitting pants when they ride a bicycle. The pants could become tangled in the gears or wheels.)

2. Why must astronauts wear safe clothing?

(To prevent accidents and to be able to do their work. You might want to compare an astronaut's clothing with a firefighter's hat and boots or a telephone lineman's insulated boots and gloves and hard hat.)

Activity Description

The *Student Liftoff* page for this lesson contains two activities: *Space Lab* and *Space Countdown.*

The *Space Lab* is a hands-on experiment that allows the student to use a jacket pocket like the pockets on an astronaut's flight suit. The students are asked: How does Velcro work on an astronaut's flight suit? The experiment demonstrates how Velcro closures keep objects inside pockets. This activity may be done at school or at home.

The *Space Countdown,* a math activity, uses deductive thinking to solve a problem. It also provides practice in using a step-by-step approach to problem solving.

Teacher Guide for solving the *Space Countdown:* Read one clue at a time. Use the information given to fill in the chart with no or yes in the appropriate boxes. When a yes is indicated, the rest of the vertical or horizontal line must be no. Complete clue by clue.

Additional Activities for School or Home

- Buy a strip of Velcro wherever sewing supplies are sold. Cut off two pieces that are three centimeters long. Glue one piece to the eraser end of a pencil. Glue the other piece to the cover of a notebook. Attach one piece of Velcro to the other piece of Velcro. What happens? Why? Explain that Velcro strips are found inside some pockets of an astronaut's flight suit. They are used to hold pens, pencils, small flashlights, and other objects and prevent the objects from flying around the cabin in the weightless environment.
- Have children imagine they are clothing designers. Have each student design and draw a flight suit that
  - is made of protective material
  - is comfortable to wear
  - is suitable for astronaut activities
  - demonstrates creativity

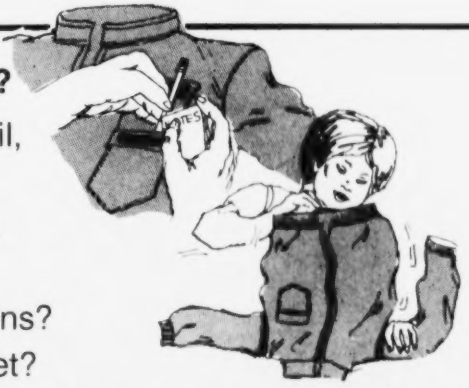
STUDENT LIFTOFF

How is an astronaut's flight suit special?
The flight suit must keep the astronaut safe and comfortable.
The shirt, jacket, and pants, made of soft blue cotton, are fireproof.

The flight suit fits close to the body to help stop accidents.
Loose clothing might catch on switches.

The flight suit has many pockets for pens, sunglasses, scissors, and small tools.
All the pockets have zippers or Velcro strips to keep the small items from floating out of the pockets.

Space Lab



How does Velcro work on an astronaut's flight suit?

You need: a jacket with Velcro on a pocket, a pencil, a small notepad.

Step 1. Put the pencil and notepad into the pocket.
Using the Velcro, close the pocket.

Step 2. Shake the jacket upside down. What happens?
What keeps the pencil and pad in the pocket?
How is the pocket on the jacket like the pocket on an astronaut's flight suit?

Space Countdown

Astronauts Joe, Sally, and Bob each put something different in their top jacket pocket. One astronaut had a pen, one had a Swiss army knife, and one had a pair of sunglasses.

Use the clues to solve the problem.
Put a yes or no in each box.

	Pen	Sunglasses	Knife
Joe			
Sally			
Bob			

Clue 1. Joe did not put a pen or sunglasses in his pocket.
Clue 2. Sally did not put a pen in her pocket.
What did each astronaut put in each pocket?

TEACHER PRINTOUT

Objectives

Students will understand the following:

- Flight suits are designed for work.
- Antigravity suits are worn during reentry to protect the astronauts.

Vocabulary

Have the students use these words as part of your motivating discussion and in the follow-up *Space Lab* and *Space Countdown* activities.

- reentry (returning from space into Earth's atmosphere)
- antigravity suit (an inflatable pair of pants with a valve that allows the pants to be filled with oxygen from a bottle)
- flight suit
- ready-to-wear
- cobalt blue
- liftoff
- headgear

Motivation

1. What do you wear to go swimming? To school? To sleep?

(Bathing suits, trunks; jeans, skirts, pants, blouses, shirts; pajamas, nightgowns. Accept any suitable answers as they relate to each part of the question.)

2. Why do we need different kinds of clothing?

(Different activities require different clothes. Close-fitting suits make it easier to swim. Loose-fitting clothes are better for sleeping. Comfortable clothes are used for work and school.)

Activity Description

The *Student Liftoff* page for this lesson contains two activities: *Space Lab* and *Space Countdown*.

The *Space Lab* is a hands-on experiment to help students understand how pleated clothing allows astronauts greater flexibility. The students are asked: How do pleats give you extra room in your clothes? The experiment compares the flexibility of an expanding folder with the flexibility of pleats in an astronaut's flight suit jacket. This activity may be done at school or at home.

The *Space Countdown*, a math activity, helps the student make calculations using addition and multiplication and provides practice in reading a chart.

Additional Activities for School or Home

- Astronauts on every Space Shuttle mission design their own patches. Have students work in small groups to design patches to be used in their future Space Shuttle missions. Each patch should include a mission number (STS is the official prefix and stands for Space Transportation System), the date, the astronauts' names, and highlights of the mission.

Patches should have both words and a picture.

Example: STS 2 11/12-11/14, 1981
Engle, Truly
tested mechanical "robot arm"

- The material used in astronauts' clothing is soaked with a fireproofing chemical. Discuss the need for special treatment of clothing, depending on how the clothing is to be used. After a rainfall, have two children do the following: One child wears sneakers, one child wears waterproof boots. Have both children walk across wet grass or through puddles. Compare what happens to the sneakers and boots. What are the differences? Why? Have children summarize the need for specially treated clothing.

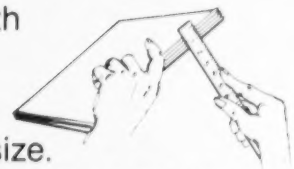
STUDENT LIFTOFF

Choosing a flight suit is easy at a NASA space center. Both men and women pick ready-to-wear cobalt blue jackets and pants along with navy blue cotton knit shirts. The jackets have pleats up the back and over the shoulders. The pleats open up to let the astronauts move easily. The outside of the flight suit has many pockets, which are used to hold tools.

At liftoff, the astronauts wear flight suits, communications headgear, and helmets. During reentry, they wear antigravity suits that protect them. Astronauts wear different uniforms at different times during the mission.

Space Lab

How do pleats give you extra room?
You need: an 8½ by 11 expanding folder, a ruler, papers, and books.



Step 1. With the folder closed, measure the width of its side at top and bottom.

Step 2. Open the folder. Add papers and books until the folder has expanded to its full size. Measure the width of the side at top and bottom again. What is the purpose of the pleats?

Step 3. Remove the papers and books. What happens? How are the pleats in the folder like the pleats in an astronaut's jacket?

Space Countdown

This chart shows the clothing astronauts wear on a six-day Shuttle trip.

CLOTHING	HOW MANY?
Underwear	1 set for each day
Shirts	1 for each day
Trousers	1 pair for 6 days
Jackets	1 for 6 days

Use the chart to answer the questions.

On a Shuttle trip:

1. How many sets of underwear for 1 astronaut? for 2 astronauts?
2. How many shirts for 1 astronaut? for 3 astronauts?
3. How many jackets for a crew of 7 astronauts?

H E A L T H

BOOK I

LIVING IN SPACE

BACKGROUND INFORMATION

Concepts

Health is an important factor in a successful Space Shuttle mission. To stay in the best possible condition, astronauts need to

- exercise regularly to counteract the effects of living in a weightless environment
- have their own lockers containing personal items and changes of clothing
- sponge bathe to keep clean

Personal Hygiene

Astronauts do not take showers on the Shuttle. Earlier showering attempts aboard Skylab failed because of weightlessness. The water floated about the cabin, and two astronauts had to spend time vacuuming up escaping water. Now astronauts on the Shuttle take sponge baths. A curtain is drawn from the bathroom door to the side of the galley where the washbasin is recessed. There is a mirror and a light above the basin and strips of tape on the wall to hold washcloths, towels, and other personal items.

Because water and soapsuds stick to the skin in the weightless environment, crew members use one washcloth for washing and a second for rinsing. Excess water is pulled into the waste water tank under the floor. The used washcloths and towels are put into a bag that hangs on the bathroom door. The bathroom on the Shuttle has a light to read by and a hatch window for an outside view.

Exercise

On Earth, some people like to exercise more than others. Aboard the Space Shuttle, astronauts have little choice. On earlier missions, scientists discovered that astronauts suffered some bone and muscle deterioration because their bodies were not getting the resistance they were used to in gravity. Today, astronauts participate in a planned exercise program to counteract the effects of a weightless environment. As a form of resistance exercise, astronauts walk a treadmill on the Shuttle. Flight doctors recommend fifteen minutes daily on seven-to-fourteen-day missions and thirty minutes daily on thirty-day missions. Exercising also helps people readjust more quickly to Earth's gravity when they return home.

The treadmill is a Teflon-coated aluminum sheet on a roller, with a bottom that locks into holes in the floor. Straps from the base of the treadmill tie around the waist. Astronauts exercise their arms by pushing upward on the bar while walking. Moving air from a nearby duct is used to dry off the perspiration produced from exercising. Otherwise, the sweat would stick to the skin and grow thicker and thicker.

While astronauts exercise, they can listen to music or look out the hatch window at the view.

Personal Storage Lockers

In the forward mid-deck cabin area, astronauts have their own storage lockers containing changes of clothing and personal hygiene kits. Kits include a toothbrush, toothpaste, dental floss, nail clippers, soap, comb and brush, lip balm, stick deodorant, and skin lotion. Shaving cream and a razor are added for the men. Although nail clippers are included, nails grow so slowly in space that they only need trimming once a month.

Medical Care

Aboard the Space Shuttle, a mission specialist provides medical care. The mission specialist may be an astronaut with paramedic training or a doctor. When there is no doctor on board, if a problem arises that is too serious for the mission specialist, there is always a doctor available for consultation at Mission Control in Houston.

A Shuttle Orbiter Medical System (SOMS), a special medical kit, is stowed in the mid-deck cabin area. This three-part system has diagnostic equipment such as a blood pressure cuff and a stethoscope, first-aid materials that include ointments, bandages, and medication, and other medical instruments, including a respirator and a defibrillator.

TEACHER PRINTOUT

HEALTH
LIVING IN SPACE

Objectives

Students will understand the following:

- Astronauts have their own personal storage lockers.
- The lockers contain clothes and personal items, such as toothbrush, toothpaste, dental floss, comb and brush.
- Astronauts use washcloths so that drops of water do not float around the spacecraft cabin.

Vocabulary

Have the students use these words as part of your motivating discussion and in the follow-up *Space Lab* and *Space Countdown* activities.

- gravity (an inward pull or force that attracts bodies to the center of other bodies, such as Earth)
- cabin (a compartment aboard the Space Shuttle where the living quarters are located)
- locker (a place to keep belongings)
- kit (a collection of personal items)
- astronaut • cloth • spacecraft

Motivation

1. How often do you wash?

(Accept any reasonable answer — in the morning, before bedtime, after sports, when I'm dirty.)

2. Why do we need to wash?

(Accept any reasonable answer — to stay clean, to wash away germs, to help us stay healthy.)

3. Pretend you are on a camping trip. There is no shower. How will you keep clean?

(Try to elicit ideas, such as using a pan with water, using wash-and-wipes, taking a sponge-type bath.)

Activity Description

The *Student Liftoff* page for this lesson contains two activities: *Space Lab* and *Space Countdown*.

The *Space Lab* is a hands-on experiment that helps students understand that on Earth, water drops are pulled downward by the force of gravity. The students are asked: How do drops of water move? A student, with a friend, explores the movement of water drops downward. This activity may be done at school or at home.

The *Space Countdown*, a math activity, requires that the students determine how many towels and washcloths an astronaut would use for a six-day mission. This involves counting by ones, counting by twos, adding, and problem solving.

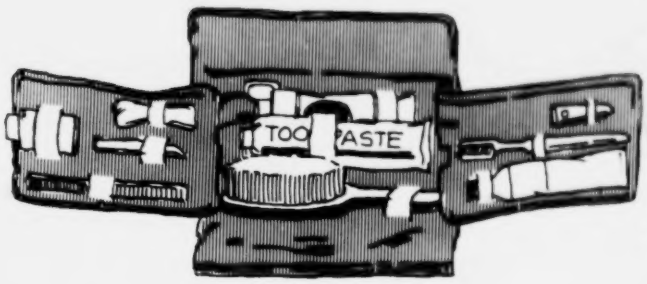
Additional Activities for School or Home

- Have students design their own personal kit to take with them on a space mission. They might want to include items from the following categories: health, personal care, appearance, recreation.
- Create a health chart to mimeograph and distribute to the students. A sample follows:

_____ 's Health Chart student's name	Mon.	Tues.
hours of sleep		
time spent exercising		
time spent washing		

Have students fill in their own chart for up to one week.

STUDENT LIFTOFF



What would you do if water floated around you?
In space, drops of water will float around a spacecraft cabin.
On Earth, a force called gravity pulls everything down.

There is not enough gravity in space to keep the water from floating.
Astronauts must use washcloths to hold the water.

They keep the washcloths in a kit.
The kit also holds a toothbrush and toothpaste, soap, and a comb and brush.

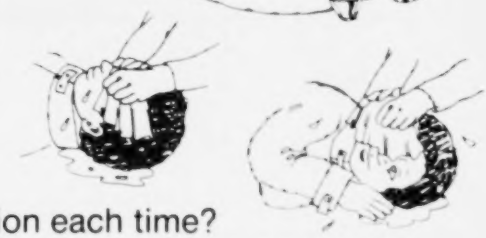
Space Lab

How do drops of water move?
You need: a raincoat or a plastic apron, some water, a friend.

Step 1. Put on the raincoat or the plastic apron.
Wash your face standing at a sink.
In what direction do the drops of water go?

Step 2. Lie down on the floor. Have your friend help you wash your face.
In what direction do the drops of water go?

Step 3. Lie on your side. Have your friend help you wash your face.
In what direction do the drops of water go?



What makes the water go in the same direction each time?
How do you think water drops would move inside a spacecraft? Why?

Space Countdown

Astronaut Sheila went on a six-day Shuttle mission.
She used one washcloth each day.
She used one towel every two days.

1. How many washcloths did she use for the 6 days?
2. How many towels did she use for the 6 days?
3. How many washcloths and towels did she use altogether?

TEACHER PRINTOUT

HEALTH
LIVING IN SPACE

Objectives

Students will understand the following:

- Astronauts do not take showers in space because weightlessness would make the water droplets float around the cabin.
- Astronauts take sponge baths instead, and use washcloths for washing and rinsing.

Vocabulary

Have the students use these words as part of your motivating discussion and in the follow-up *Space Lab* and *Space Countdown* activities.

- gravity (an inward pull or force that attracts bodies to the center of other bodies)
- locker (a place where an astronaut keeps changes of clothes and a kit containing personal items)
- astronauts
- washbasin
- sponge bath
- sealed
- kit

Motivation

1. Ask students how many of them take showers? Baths? How often? Why?

(Accept all reasonable answers, including to get clean, to wash away dirt, when I'm getting dressed up, when I come inside after playing outside.)

2. Suppose you were sick and could not take a bath or a shower. What could you do to freshen up?

(Use a damp towel, use a wash-and-wipe.)

3. What is a sponge bath?

(A bath where you use a sponge or cloth or towel to wash yourself when there is no bath or shower available.)

4. In what situations might you take a sponge bath?

(If you are visiting a friend, taking a long car trip, camping out.)

Activity Description

The *Student Liftoff* page for this lesson contain two activities: *Space Lab* and *Space Countdown*.

The *Space Lab* is a hands-on experiment that gives the students an opportunity to make and use an in-flight exerciser. The students are asked: How can astronauts exercise in flight to stay healthy? Working with the help of an adult, they make an in-flight exerciser out of a broom handle and an old bicycle inner tube. They also learn to take their own pulses. This activity may be done at school or at home.

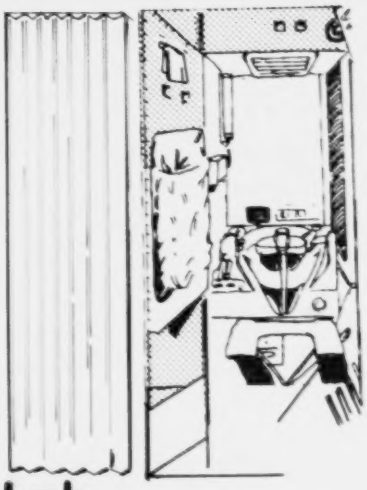
The *Space Countdown*, a math activity, helps teach students to recognize different parts of a bar graph (such as titles and headings) to find facts shown by the graph, and to compare amounts of time.

Additional Activities for School or Home

- Everyone is thinking more about exercise these days. Have the students speak to children and adults they know and find out how to do at least two different kinds of exercise. Some exercises strengthen muscles such as the heart; others are for stretching and flexibility. Plan a special Exercising for Health day. Students take turns teaching their exercises and leading the class. The class might vote for favorites. You might start a daily ten-minute workout period.

- Have a brainstorming session, sharing the different ways to wash without actually taking a bath or shower. List ideas on the board. Remember, all ideas are acceptable and no judgment is made during brainstorming. Discuss how the ideas might work. Have the students create imaginative pictures illustrating the ideas. Use a Bathless Bath bulletin board display.

STUDENT LIFTOFF



On the Space Shuttle, astronauts use a bathroom that can be closed off with a curtain. There is a washbasin, warm water, and soap.

Strips of tape hold a towel and a wash-cloth to the wall.

Astronauts take sponge baths.
They use one cloth with soap to wash and another cloth to rinse.
Used towels go into a bag and are sealed in plastic.

Space Lab

You will need an adult to help you with this experiment.
How can astronauts exercise in flight to stay healthy?

You need: a broom handle, an old bicycle inner tube.

Step 1. With an adult, make an in-flight exerciser. Use an inner tube to make a loop hitch around a broom handle. Tighten.

Step 2. Count your pulse beats for ten seconds by placing your fingers at your wrist. (The adult can help you.)

Step 3. Place one foot in the open end of the exerciser loop. Hold the broom handle with both hands. Pull the broom handle against your foot. Release. Do this for thirty seconds. Take your pulse again.

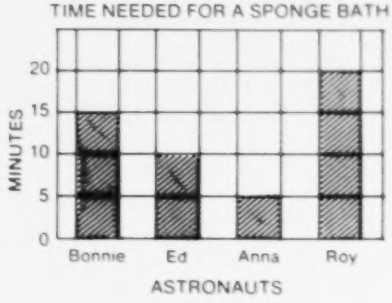
How have the beats changed? How do your muscles feel? How can an exerciser help an astronaut?

Space Countdown

The graph shows how long it took some astronauts to take a sponge bath.

Use the graph to answer the questions.

1. Who took the least amount of time?
2. Who took the most amount of time?
3. How long did it take for Bonnie to sponge bathe?



TEACHER PRINTOUT

HEALTH
LIVING IN SPACE

Objectives

Students will understand the following:

- Astronauts must exercise every day to counteract the effects of weightlessness in space.
- Astronauts use a form of resistance exercise, walking a treadmill for fifteen to thirty minutes daily.
- While exercising, crew members can view Earth through a hatch or listen to their favorite music.

Vocabulary

Have the students use these words as part of your motivating discussion and in the follow-up *Space Lab* and *Space Countdown* activities.

- gravity (an inward pull or force that attracts bodies to the center of other bodies)
- weightless (having little or no weight because the force of gravity has been balanced by the force of forward speed)
- treadmill (a machine moved by walking motion)
- duct
- perspire

Motivation

1. Why do people exercise?

(To keep our bodies healthy; to strengthen our muscles; to feel good.)

2. Discuss what kinds of exercise are popular now.

(Jogging, walking, swimming, tennis, racquetball, golf, baseball, soccer, any reasonable answer.)

3. Ask students what kind of exercise they do.

(Physical education in school, sports teams, skating, bike riding, swimming.)

Activity Description

The *Student Liftoff* page for this lesson contains two activities: *Space Lab* and *Space Countdown*.

The *Space Lab* is a hands-on experiment using exercises devised by NASA (National Aeronautics and Space Administration) for space travelers. The students are asked: What special exercises must space travelers do to stay fit? The exercises used are isometric. They strengthen muscles through the use of immovable resistance. This activity may be done at school or at home.

The *Space Countdown*, a math activity, has students read an exercise chart to answer questions. Students learn to identify different parts of a chart, such as headings and titles, and to locate and compare the information presented.

Additional Activities for School or Home

- Suggest that children turn part of the classroom into a Space Shuttle using chairs, tables, large empty boxes. Have children simulate exercising in space in a weightless environment. Act out walking the treadmill, jogging, stretching, doing jumping jacks, and touching toes.

- Ask students to make believe they are weightless for a day. How would their lives be different? Eating? Sleeping? Dressing? Washing? Playing? Have them share their ideas by writing stories or letters to friends, by drawing pictures, making tape recordings, or pretending they are being interviewed on TV. Have them describe how they became weightless, what things they can no longer do, what new things they are able to do, any problems they have, and how they will return to normal.

STUDENT LIFTOFF

Why must astronauts exercise every day aboard the Space Shuttle?

In the weightlessness of space, there is no pull against an astronaut's body.

Bones and muscles get weak when there is not enough gravity.

Astronauts walk a treadmill for fifteen to thirty minutes each day to keep their bones and muscles healthy. Straps attached to the treadmill make their arm and leg muscles work harder. This exercise makes sweat, which sticks to their skin. Moving air from a nearby duct dries off the sweat.

Space Lab

What special exercises must space travelers do to stay fit?

You need: a clock with a second hand.

Step 1. Grasp your right hand with your left hand, palms facing. Pull in opposite directions for five seconds. Release.

Step 2. Repeat this exercise for ten seconds; for twenty seconds.

Step 3. Place hands against a wall or stationary object and practice running in place while pushing for five minutes.

How is this exercise like running on a treadmill?

Space Countdown

Juan, Rika, and Lori tried one of the special space traveler exercises. Their teacher made a chart to show how their pulse beats changed.

Use the chart to answer the questions.

1. Who had the lowest pulse rate before exercising?
2. Who had the lowest pulse rate after exercising?
3. Who had the highest pulse rate after exercising?
4. Whose pulse rate changed the most?

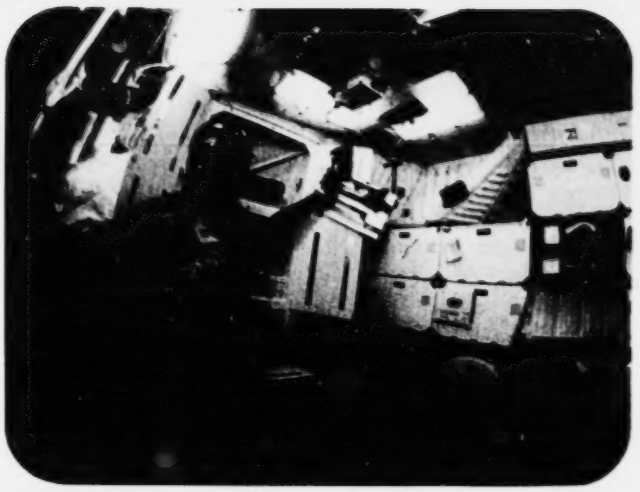
EXERCISE CHART

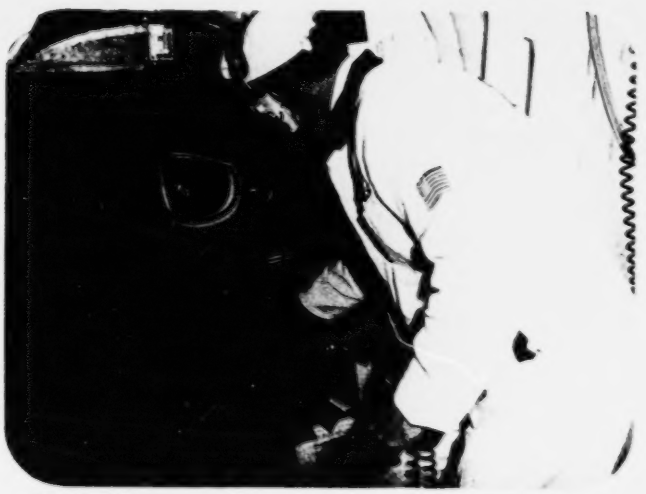
	Pulse Beats Before	Pulse Beats After
Juan	78	129
Rika	82	134
Lori	91	125

H O U S I N G

BOOK I

LIVING IN SPACE





BACKGROUND INFORMATION

Concepts

The Space Shuttle is an astronaut's home in space. The spacecraft cabin

- consists of three levels: an upper flight deck; a lower life-support, housekeeping, and storage deck; and mid-deck living quarters
- provides astronauts with private places to sleep
- allows astronauts entry to other parts of the Shuttle through hatches and air locks

Space Shuttle Deck Areas

The cabin of the Shuttle has three levels. The top level is the flight deck, where the commander and pilot handle the spacecraft. The lowest level contains life-support and housekeeping equipment. The mid-deck living area is a room measuring about 4 meters long and ranging from a 3.7-meter width at the back to a 2.7-meter width at the front. This level is filled with equipment, such as a private toilet, a washbasin with a mirror, a galley with an oven, drawer-size lockers, bunk beds, and the air lock that leads into the cargo bay. Although much roomier than early spacecraft, the cabin is small compared to Skylab, which was about the size of a small three-bedroom house. The cabin area is used for exercising, and sometimes various experiments are performed here.

Sleeping Accommodations

Sleeping arrangements aboard the Shuttle have been designed with a weightless environment in mind. Because there is no up or down in such an environment, a two-level bunk bed actually provides sleeping space for four people. The first person sleeps on the top bunk, the second on the lower bunk. A third person sleeps on the underside of the lower bunk, actually facing the floor. A fourth person sleeps vertically in another bunk set against one end of the two-level bed. Bunks are more than 1.8 meters (6 feet) long and about .75 meters (30 inches) wide. Each bed is a padded board with a fireproof sleeping bag attached to it. The bag has perforations for ventilation. In Earth's gravity, your body sinks into the mattress. In the Space Shuttle, your body hardly feels the bed board. Weightlessness gives the illusion of a mattress and pillow beneath you.

Astronauts zip themselves inside the sleeping bags, leaving their arms outside. They snap together straps that circle the waist. Each sleeping compartment has a light for reading and side panels that can be shut for privacy. Eyeshades and earmuffs are available to reduce cabin light and noise. If all seven members of the Shuttle crew decide to sleep at one time, three more sleeping bags will be attached vertically to the bulkhead storage lockers. Two of the crew members must wear communications headgear so that they can receive calls from Mission Control or hear alarms.

Hatches and Air Locks

Crew members move about the Shuttle through hatches and air locks. Initial entry into the Shuttle is through a circular hatch (one meter in diameter) located on the left side of the Shuttle. This hatch, which opens outward, leads directly into the mid-deck cabin. Three crew members sit here for liftoff. Other astronauts pass through an open hatch into the flight deck for launch and reentry.

Astronauts wear space suits (extravehicular mobility units) when Space Shuttle activities involve extravehicular activity (EVA). An air lock, a small cylindrical chamber usually located in the back of the mid-deck cabin, is used by the astronauts to move from the controlled environment of the cabin to the environment of space. The astronaut enters the air lock hatch and changes into EVA gear. After depressurizing the air lock, the astronaut opens the outer hatch and works in the cargo bay or in space.

NASA

TEACHER PRINTOUT

Objectives

Students will understand the following:

- Proper sleeping quarters are provided for each astronaut.
- Astronauts sleep in fireproof sleeping bags attached to padded boards.
- Because of weightlessness, astronauts can sleep facing up, facing down, or even standing.

Vocabulary

Have the students use these words as part of your motivating discussion and in the follow-up *Space Lab* and *Space Countdown* activities.

- weightless (having little or no weight because the force of gravity has been balanced by the force of forward speed)
- sleeping bag
- fireproof
- eyeshades
- earmuffs
- astronauts

Motivation

1. Have you ever slept in a sleeping bag? What was it like?

(Accept any answers that make sense. It was cozy. It felt too hard.)

2. Astronauts sleep in sleeping bags on the Space Shuttle. Why do you think this is so?

(There isn't enough room for regular beds. They can be rolled up and put away during the day. Sleeping bags help keep them warm.)

3. Explain that gravity is a force that holds us down to Earth. On board the Shuttle there is not enough gravity to hold astronauts down. How could a sleeping bag help an astronaut to sleep aboard the Shuttle?

(It stops the astronaut from floating around.)

Activity Description

The *Student Liftoff* page for this lesson contains two activities: *Space Lab* and *Space Countdown.*

The *Space Lab* is a hands-on activity that simulates what it is like to sleep in a sleeping bag the way an astronaut does. The students are asked: What is it like for an astronaut to sleep in a sleeping bag? Using an actual sleeping bag, students can zip themselves inside, have their arms strapped down, and add earmuffs and eyeshades to eliminate noise and light. It is important to help students understand that because of weightlessness, astronauts must be strapped down, or they would simply float about the cabin. This activity may be done at school or at home.

The *Space Countdown*, a math activity, has the student record the results of six tosses, and compare larger and smaller.

Additional Activities for School or Home

- As a follow-up activity to the Space Lab, students might be helped to brainstorm words that describe how an astronaut would feel sleeping facing up, facing down, standing up. Discuss other unusual sleeping arrangements that students have been exposed to — cots, couches, chairs, hammocks, car seats. Create a class poem incorporating some of the brainstormed words.
- Have students draw pictures showing themselves sleeping in unusual settings or situations, perhaps on board the Shuttle.

STUDENT LIFTOFF

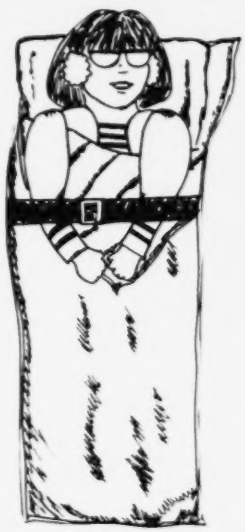
Have you ever slept in a sleeping bag?
On the Space Shuttle, each bed is a fireproof sleeping bag.
The bag rests on a padded board.

At bedtime you zip into the bag and strap yourself in.
Two astronauts sleep facing up.
One astronaut sleeps facing the floor.
Another astronaut sleeps standing up.

Which way would you choose to sleep?

Space Lab

What is it like for an astronaut to sleep in a sleeping bag?
You need: a sleeping bag, a belt, earmuffs, eyeshades, a friend.



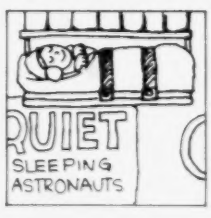
Step 1. Take off your shoes. Zip yourself inside the sleeping bag. Leave your arms outside. How do you feel?

Step 2. Put on the earmuffs and eyeshades. Wait two minutes.
How do you feel now?
Why do astronauts cover their eyes and ears when they sleep?

Step 3. Have a friend strap the belt around the sleeping bag so your arms are held down. Wait two minutes.
How do you feel now?
Why do you think astronauts must be strapped down?

Space Countdown

Cut out the pictures of the sleeping astronauts. Paste them together with a piece of cardboard in between. Toss the card six times. Put a check in the correct box on the chart after each toss.



TOSSES	1	2	3	4	5	6
Up						
Down						

1. How many times did the astronaut sleep facing up?
2. How many times did the astronaut sleep facing down?
3. Which way to sleep had the higher score? How much higher was it?

TEACHER PRINTOUT

Objectives

Students will understand the following:

- Astronauts move about the Shuttle's decks and work areas through hatches and air locks.
- Hatches lead from one deck to another.
- Air locks are special kinds of openings made up of two hatches and a connecting space.

Vocabulary

Have students use these words as part of your motivating discussion and in the follow-up *Space Lab* and *Space Countdown* activities.

- hatch (an opening or doorway that leads from one place to another)
- air lock (two hatches with space in between)
- cargo bay (the large main body of the Shuttle where the payload or cargo is stored)
- mid-deck • flight deck

Motivation

1. Does your house or apartment have different rooms? Why?

(Different rooms are used for different activities.)

2. What different kinds of rooms might we expect to find on the Space Shuttle? Why?

(Astronauts need different rooms for different activities too. Explain how the Shuttle is much larger than older spacecraft such as **Apollo** and **Gemini.**)

3. How do you get from one room to another room at home?

(You walk through doors or other openings.)

Activity Description

The *Student Liftoff* page for this lesson contains two activities: *Space Lab* and *Space Countdown.*

The *Space Lab* is a hands-on simulation helping the student understand how an air lock is set up. The students are asked: How does an astronaut move through an air lock? A large cardboard box is used to create the illusion of the air lock drum aboard the Shuttle. If no board compass is available, substitute a string and pencil. This activity may be done at school or at home.

The *Space Countdown*, a math activity, has the student counting by twos from 2 through 46. Students can then color the resulting picture of an air lock.

Additional Activities for School or Home

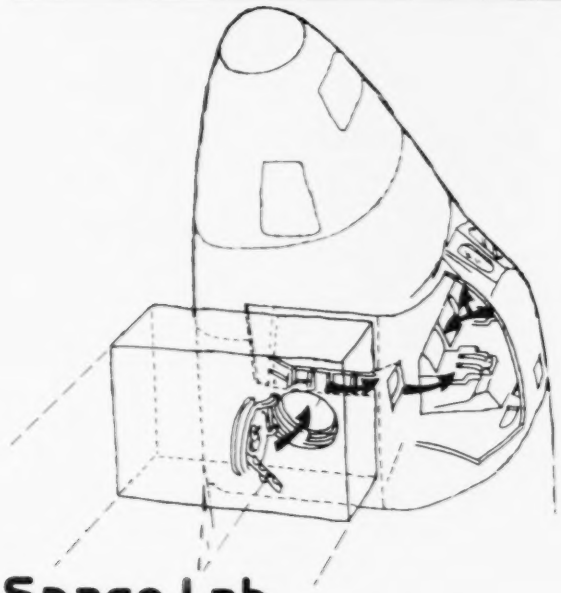
• As an extension of the *Space Countdown* activity, students could be helped to create their own connect-a-dot picture illustrating other parts of the Space Shuttle cabin.

• Students could write stories entitled "The Day I Visited the Space Shuttle." Such stories should include information about how they moved from one deck area to another using hatches and air locks. Use the words below as a starter word bank. Have the children work in pairs, brainstorming other words to add to their personal word banks before they start writing.

Word Bank

hatch	flight	crawl	ladder	air lock	shuttle
crew	up	doorway	floating	job	down

STUDENT LIFTOFF



Astronauts go through hatches and air locks when they move from one part of the Space Shuttle to another.

A hatch is an opening from one deck to another deck.

An air lock is two hatches with space in between.

Before liftoff, crew members crawl through a hatch into the mid-deck cabin.

The commander and pilot continue up a ladder through an open hatch to the flight deck.

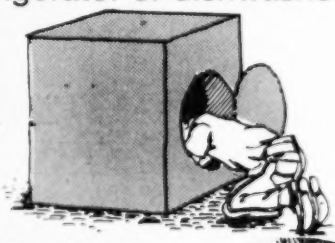
During the flight, astronauts pass through an air lock to work in the cargo bay.

Space Lab

You will need an adult to help you with this experiment.

How does an astronaut move through an air lock?

You need: one large cardboard box (from a new refrigerator or dishwasher), an Exacto knife, a teacher's board compass.



Step 1. Use your teacher's board compass to draw large circles on opposite sides of the carton.

Step 2. Have an adult cut open the circles, leaving one side of each circle attached to the box.

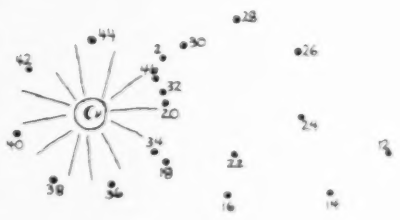
Step 3. Open one hatch (circle). Crawl inside. Close the hatch. Move to the other side of the box. Open the hatch (circle). Crawl out. Close the hatch.

How is the cardboard box like an air lock?
Why does an astronaut use an air lock?

Space Countdown

Can you count by twos?
Connect the dots starting at 2 and going to 46.

What picture did you make?
Color the picture.



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TEACHER PRINTOUT

Objectives

Students will understand the following:

- The Shuttle is an astronaut's home in space.
- The Shuttle has three decks: the flight deck, an equipment storage deck, and the mid-deck living area.
- Cabin areas are comfortable places to live.

Vocabulary

Have the students use these words as part of your motivating discussion and in the follow-up *Space Lab* and *Space Countdown* activities.

- flight deck
- equipment deck
- mid-deck living area
- experiments
- hatch
- commander
- pilot

Motivation

1. What are some of the different parts of your house or apartment?

(Accept any logical answers — bedrooms, kitchen, living room, etc.)

2. Are there any rooms in your home that are used for different activities? Which room and for what kind of activities?

(Family rooms, dens, and sometimes kitchens are multipurpose rooms.)

3. What kinds of things do both you and astronauts need in order to live?

(Air, food, water, others as applicable).

Activity Description

The *Student Liftoff* page for this lesson contains two activities: *Space Lab* and *Space Countdown.*

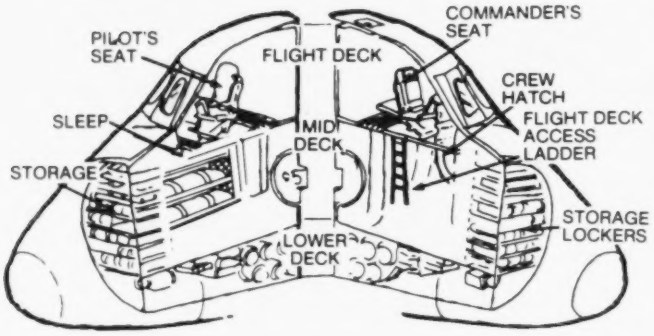
The *Space Lab* is a hands-on activity that has the students create a facsimile of the Space Shuttle cabin. The students are asked: What does an astronaut's home in space look like? Students use a plastic jug and cardboard to create their version of the Shuttle cabin. You may prefer to have adults handle all cutting. This activity may be done at school or at home.

The *Space Countdown,* a math activity, has the students find their way through a maze by following movement directions. Before doing this activity, ask students to pace a defined floor area using forward, right, and left commands. These commands will reinforce computer skills. With each square representing ten units, students must also equate number values.

Additional Activities for School or Home

- Draw or paint pictures of Shuttle crew members relaxing in their mid-deck living quarters. Pretend you are a member of the crew. Write a letter to your family back on Earth explaining how you spend your free time.
- Try this imagery activity. Have students sit comfortably in their seats and relax. Have them close their eyes, clear their minds, and allow their brains to fill up with lovely, interesting "imaged" pictures. Slowly read through the following: "Relax. Feet comfortable on the floor. Let your mind go blank. Now fill your mind with a warm, glowing sun. You feel comfortable, relaxed, happy. See yourself entering the Shuttle, strapping yourself in, and getting ready for launch. Feel the power of the launch. Watch Earth streaking by. You're in orbit. Undo your belt, get up, and walk around the cabin. See yourself doing your work. See yourself relaxing ....." After imaging, have the students share what they saw and what they felt.

STUDENT LIFTOFF



The Space Shuttle is an astronaut's home in space. Its cabin has three different sections. On the upper flight deck are the controls for the commander and pilot. The bottom deck holds different kinds of equipment.

The mid-deck of the cabin is where the crew lives. Here food is stored, heated, and eaten. There are bunks for sleeping. The bathroom is also on this deck. Crew members exercise in the mid-deck and may also perform experiments.

The cabin areas provide air, water , and comfortable temperatures.

Space Lab

You will need an adult to help you with this experiment.

What does an astronaut's home in space look like?

You need: 1 large empty plastic jug, cardboard, scissors, glue.

Step 1. Have an adult split open a large plastic jug.

Step 2. Cut cardboard semicircles to fit in the jug. Glue the circles in place to make three decks. Cut out the hatch.

How are the different decks like the different parts of your home?

Why do astronauts work and sleep on different decks?

How do the astronauts move from one deck to another?

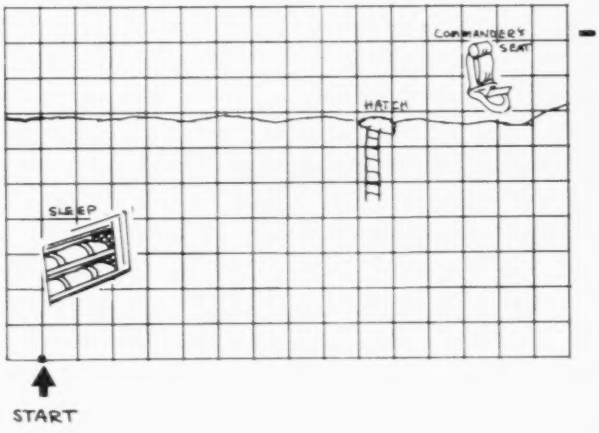
Space Countdown

Help the Shuttle commander go from the sleeping quarters to the commander's seat.

Follow the directions.

Each square stands for ten moves.

a. forward 20	e. right 20
b. right 20	f. left 40
c. forward 50	g. right 30
d. left 10	h. left 10



COMMUNICATION

BOOK I

LIVING IN SPACE

BACKGROUND INFORMATION

Concepts

Communication is one basic requirement for a successful space mission. Astronauts must be able to communicate with ground control and with crew members in other parts of the Space Shuttle. Communication includes the use of

- personal headsets
- simple, concise language
- computers

Personal Headsets

Crew members use a headset to communicate with each other in different parts of the spacecraft. The headset consists of an earphone, a microphone, and a clip. A cable connects the headset to a control unit that is attached to the astronaut's clothes. The control unit is also connected to eight intercom terminals in the crew compartment and permits communication with ground control. There is a volume control on top of the communication unit. Five channels are available: two for air-to-ground, one for air-to-air, and two for the intercom. Two of the terminal units have a built-in speaker/microphone that allows use without the headset. A wireless microphone, consisting of a small transmitter, attaches to the headset so that loose cables do not get in the way.

The Shuttle space suit uses a Snoopy-type skullcap with a microphone and earphones for communication. This black-and-white snug-fitting cap resembles Snoopy's ears. It is worn under the space helmet.

Simple, Concise Language

Communication is necessary between the Shuttle and ground control in order to collect information from the astronauts on board. The language used must be clear, concise, and easily understood. The words cannot be mistaken for other words. Astronauts and ground controllers use an appropriate checklist of spoken instructions. It may vary slightly from crew to crew. The name of the spacecraft is always used by ground control during communication and the name **Control** is always used when an astronaut starts a communication.

Computers

Five onboard computers handle all data processing for the Space Shuttle missions. The computers can operate independently or together. There are two banks of two computers with a backup computer that works as a tie breaker when there is a disagreement.

Prior to the flight, the computers are programmed with information. Two magnetic-tape mass memories provide an additional thirty-four million types of information to the total memory of the computers. The data processing system translates signals to and from the orbiter's systems and sensors into computer language. The system then displays what is happening and allows the astronauts to talk to the system.

The computer program, controlling each flight from prelaunch to landing, is divided into nine major parts. The computers control the basic running of the spacecraft, continually recompute the flight path, signal rockets to fire, process medical data from the crew, and monitor the livability and air content of the spacecraft. Using sensors and tapes, the computers record the results of experiments and monitor equipment performance.

The ability of the Shuttle's computers to control virtually every phase of the mission — from final countdown to reentry — has been successfully demonstrated on all flights.

Extravehicular Communication

Astronauts working outside the Space Shuttle must be able to communicate with crew members inside the spacecraft. An extravehicular communicator attaches to the upper portion of the space suit life support system.

This backpack communicator, which weighs about four kilograms, provides radio communication and sends medical information about the astronaut to the spacecraft and to flight surgeons in the Mission Control Center in Houston.

TEACHER PRINTOUT

Objectives

Students will understand the following:

- Speaking and listening is a major part of communication.
- Astronauts use communication headsets consisting of microphones and earphones.
- A black-and-white Snoopy headset is part of a space suit.

Vocabulary

Have the students use these words as part of your motivating discussion and in the follow-up *Space Lab* and *Space Countdown* activities.

- microphone (something you speak into that picks up sounds)
- earphones (something you listen through that sends sounds to your ears)
- meter (the basic unit of length in the metric system, equal to 100 centimeters)
- communication
- headset

Motivation

1. How does a baby let you know what it needs?

(The baby cries, pulls at you, tries to get your attention.)

2. How do you let someone know what you need?

(You use words to tell them.)

3. Why would you use a headset to listen to a record, tape, or television show?

(Accept any answer that indicates that sound is directed into the ear without disturbing others around you.)

4. Have you ever used a microphone? What happened?

(Accept any answer that explains that microphones amplify sound.)

Activity Description

The *Student Liftoff* page for this lesson contains two activities: *Space Lab* and *Space Countdown.*

The *Space Lab* is a hands-on experiment demonstrating that sound travels through different materials. In this experiment, sound travels through a string. The students are asked: What do we need to communicate? The students use the string and Styrofoam cups to simulate the use of a microphone and earphones. This activity may be done at school or at home.

The *Space Countdown*, a math activity, requires the student to count squares, add and subtract, and compare quantities.

Additional Activities for School or Home

- Have students use the telephone to call a friend. Have them explain to the friend that they are trying an experiment and that they are going to ask a question. Then turn the telephone earpiece upside down. Have them ask the question, What happens? Why? What part of the telephone is like a microphone? What part is like earphones?
- Create a class collage using pictures that students cut out of magazines. The pictures should all show different ways that people communicate with one another. You might wish to discuss different kinds of communication such as verbal and nonverbal.

STUDENT LIFTOFF

How do people know what you need?
You tell them.
How do you know what people need?
They tell you.
Speaking and listening is called communication.

Astronauts use a microphone and earphones to communicate.
This is called a headset.

Another kind of headset looks like Snoopy's black-and-white ears.
It is used when an astronaut wears a space suit.

Space Lab

What do we need to communicate?

You need: a friend, a sharp pencil, 2 Styrofoam cups, thin string 4 meters long (enough to stretch across a room).

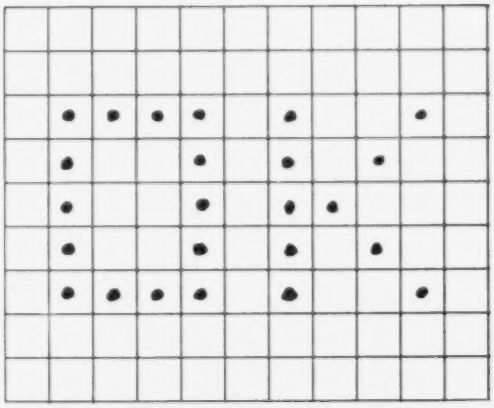
Step 1. Using a sharp pencil, punch a **very small** hole in the center of the bottom of each cup.

Step 2. Put the ends of the string through the hole in each cup and tie **large** knots.

Step 3. With a friend, stretch the string tight. Take turns talking into the cups.
How does the sound get to you?
What part of the telephone is the microphone? the earphone?
How is your cup telephone like the astronauts' headsets?

Space Countdown

A computer puts out information. Color in each square that has a dot in it to show computer letters.
Answer the questions.



1. How many squares did each letter use?
2. How many squares did you use altogether?
3. How many more squares did one letter use than the other letter?

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TEACHER PRINTOUT

COMMUNICATION
LIVING IN SPACE

Objectives

Students will understand the following:

- Astronauts must communicate with ground control and with other astronauts on board the Space Shuttle.
- Astronauts must speak in simple, uncluttered language.
- Astronauts have their own special language.

Vocabulary

Have the students use these words as part of your motivating discussion and in the follow-up *Space Lab* and *Space Countdown* activities.

- SRB (solid rocket booster)
- roger (okay)
- sep. (separation)
- Do you copy? (Do you understand?)
- Mission Control or ground control (control bases on Earth)
- communication
- language

Motivation

1. Ask students, Have you ever had trouble understanding what your teacher told you to do? Why?

(Words were too hard to understand. I wasn't listening. Teacher talks too fast. Accept any logical answers.)

2. Which of the following sentences is easier to understand?

a. At the completion of your assigned work, you may approach the puzzle corner and proceed to choose an appropriate activity.

b. When you're done with your work, pick a puzzle.

(Sentence **b** is simpler and more to the pint. There is less chance to be misunderstood.)

3. Explain what kind of secret language you and a friend or relative have shared.

(Accept any appropriate answers.)

Activity Description

The *Student Liftoff* page for this lesson contains two activities: *Space Lab* and *Space Countdown*.

The *Space Lab* is a hands-on experiment in which students participate in the game called telephone. The students are asked: Do we always understand what someone says? Students pass a sentence from one person to the next person down a line of five friends. They then compare the final version of the sentence with the original version. This activity may be done at school or at home.

The *Space Countdown*, a math activity, requires students to work addition and subtraction problems and then match answers to letters. The result is an astronaut message that reads, "Do you copy? Over."

Additional Activities for School or Home

- Have students act out scenes between astronauts and Mission Control. Use clear, simple astronaut language. Samples: roger; over; looks good; complete check; go for launch; two, one, zero, liftoff.
- Have two students or two teams of students work with identical sets of blocks. One student orally describes an arrangement of the blocks. The other student, who cannot see the arrangement, attempts to duplicate it by following the first student's directions. You might suggest that the children make believe that the description is coming from a distant planet. If time permits, allow the students to try again. They should be more adept the second time.

STUDENT LIFTOFF

Yakety, yakety-yak.
People are always talking to each other.
Talking and listening is called communication.

Astronauts communicate with ground control and with other astronauts on board the Space Shuttle.
They must use clear, simple language.

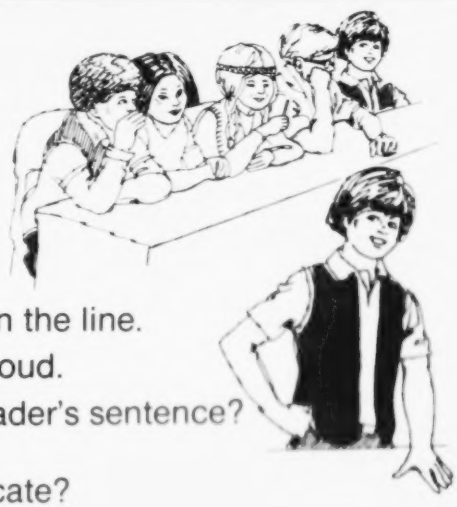
Here is a communication between the astronauts and ground control at takeoff:

A. Control, this is Columbia. We have SRB burnout, over.
G: Roger. You look good. Go for SRB sep. Do you copy? Over.
A: Roger, Mission Control. Out.

Space Lab

Do we always understand what someone says?

You need: 4 friends, a quiet room.



Step 1. Choose a leader. Have the leader make up a short funny sentence. Each word must start with the same letter.

Step 2. Sit in a line, one next to the other. Whisper the sentence to the next person. Pass it down the line.

Step 3. Have person number five say the sentence aloud.

Was the spoken sentence the same as the leader's sentence?
How do you explain what happened?
How well did you and your friends communicate?

Space Countdown

Work each problem. Find the letter that matches the answer.

Fill in the missing letters. What is the astronaut's message?

6	13		10	4	12		4	15	10	8		16	9	4	8
+4	−6		−9	+3	−8		+4	−8	−4	−7		−9	−6	+5	−3
10															
D	___		___	___	___		___	___	___	___	?	___	___	___	___ .

Blastoff #'s

D = 10
E = 9
C = 8
O = 7
P = 6
R = 5
U = 4
V = 3
W = 2
Y = 1

TEACHER PRINTOUT

Objectives

Students will understand the following:

- Communication in and from space is aided by five computers.
- Computers are preprogrammed before launch.
- Computers control all aspects of Space Shuttle flights.

Vocabulary

Have the students use these words as part of your motivating discussion and in the follow-up *Space Lab* and *Space Countdown* activities.

- programmed
- data
- information
- computer
- mission
- systems
- plot point

Motivation

1. **Have you ever used a computer with a disk? How does the computer know how to answer what you say or what your friend says?**

(Accept any answer indicating that the computer has been programmed to respond in different ways to different questions.)

2. **How do you and your friends decide what game to play when you disagree?**

(One person may be more forceful, you may give in to avoid an argument, or everyone might vote to decide.)

Activity Description

The *Student Liftoff* page for this lesson contains two activities: *Space Lab* and *Space Countdown.*

The *Space Lab* is a hands-on experiment that allows students to type in and run a computer program. If no computer is available, the program is simple enough to be done mentally or with paper and pencil. This program will run on an Apple computer; minor changes may be necessary for other computers. The students are asked: How does a computer use stored information? In this instance, the computer has been preprogrammed to do subtraction problems and to print out the answer. This activity may be done at school or at home.

The *Space Countdown*, a math activity, requires a student to follow directions in order to locate plot points on a graph. You might want to do a practice graph on the board with the entire group. Stress that the first number moves horizontally and the second number moves vertically. (The plotting results in the name E.T.)

Additional Activities for School or Home

- You can learn to be a good test-taker by following some simple rules. Read the rules. Put them in the correct order. Write the numbers where they belong on the flowchart. The first one has been done for you.

1. Go to the next question.
2. Check all your work.
3. Pay careful attention to the directions.
4. Read the first question.
5. Put your pencil down.
6. Answer the question.

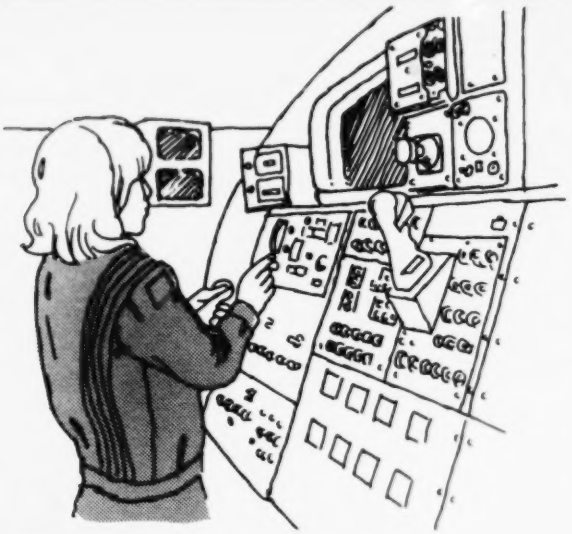
(Answer is 3-4-6-1-2-5.)

- Have students write diamantes (dee-ah-mahn-tays). A diamante is a diamond-shaped 5-line poem that starts with one idea and ends with another related idea.

Diamante Example:

Computers
(noun)
Humming, working
(verbs)
Machines, space mission, liftoff
(related nouns)
Roaring, speeding
(verbs)
Space Shuttle
(noun)

STUDENT LIFTOFF



Aboard the Space Shuttle, five computers can work alone or together. They check on each other. They vote to solve an argument.

Before liftoff, millions of pieces of information are programmed into the computers. The computers use this information to control the whole flight. They make sure all systems are working. They take in data and send it to Earth.

Computers can answer over a thousand questions asked by the astronauts. Astronauts need computers for a successful mission.

Space Lab

How does a computer use stored information?

You need: a computer or paper and pencil

Step 1. Type:

```
10  HOME          40  LET C = A-B
20  LET A = 10    50  PRINT C
30  LET B = 6     60  END
```

Step 2. Type: RUN What does the computer print?
What has the computer been programmed to do?

Step 3. If you do not have a computer, be a computer yourself. Solve the problem. PRINT C.

Step 4. Write a computer program so that A = 43, B = 15.

Space Countdown

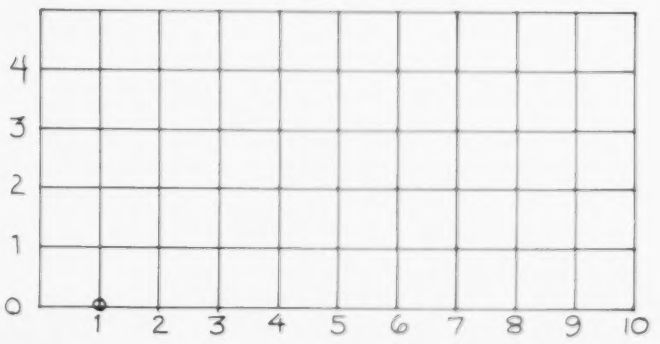
A computer can follow directions. For each two numbers, locate the plot point. The first number tells how far **across** to go. The second number tells how far **up** to go.

Start at 0. Put a dot at the plot points.

For example, (1,0) is done for you.

(1,0) (1,4) (2,0) (7,4) (6,0)
(1,1) (2,4) (3,0) (6,3)
(1,2) (3,4) (5,4) (6,2)
(1,3) (2,2) (6,4) (6,1)

Whose special name did you plot?



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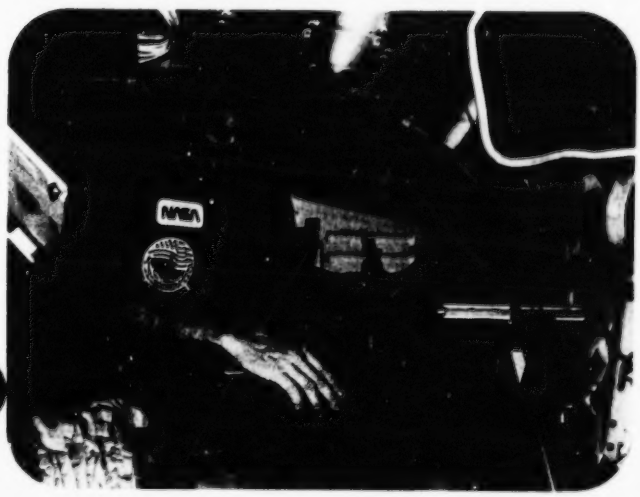
WORKING

BOOK 1

LIVING IN SPACE



BACKGROUND INFORMATION

Concepts

Weightlessness controls living in space.

Weightlessness affects

- the way astronauts live and work
- the body functions, body measurements, and posture of the astronauts
- the different ways in which astronauts must perform their jobs

Weightlessness

On Earth, the force of gravity attracts all bodies toward the center of the planet. This force gives objects their weight. Objects are pulled down or held down. In space, objects and people are neither pulled nor held down. As a result, people in space experience weightlessness.

In an orbiting spacecraft, Earth's gravity continues to "pull" upon the spacecraft. However, the force caused by the forward speed of the spacecraft balances the effect of gravity upon the spacecraft itself and on the objects within it. Weightlessness results from the balance between the force of gravity and the force of the forward speed. It is interesting to note that when the Shuttle fires its thruster, the astronauts feel the gravitational force quite dramatically.

In fact, people in orbit have some weight, but the amount is so slight that they do not feel it. Scientists use the term microgravity to describe the small amount of weight that people and objects have in space.

The Way Astronauts Live and Work

What happens to objects in a weightless environment? They float. People float, forks and spoons and food float, equipment floats. Initially most of us react with humor to the idea of floating. However, in space, bread crumbs floating about the spacecraft can actually be dangerous, both to the people who might inhale them and choke and to the equipment that might be ruined if the crumbs were to get inside.

Water presents another problem in space. Water does not drip down, but instead floats upward and forms floating spheres. Scientists have had to take this into consideration when designing spacecraft and have had to plan how astronauts will drink, how they will wash, and how they will dispose of body wastes.

Body Changes

Weightlessness affects our bodies in many ways. One way is the shifting of blood from the lower part of the body to the upper part. This causes many changes. Eyes will seem smaller because the face will be fuller; wrinkles will disappear; waistlines will shrink three to five centimeters; and shoelaces will have to be tightened. Another effect is adding three to five centimeters in height because the vertebrae of the backbone do not have gravity pulling them down. Weightlessness also alters posture. The body bends at the joints and hips, and knees flex into a slight crouch. Unless arms are held down, they tend to float, and the toes will point. Space boots have special attachments that raise the heels and help a person stand with his or her feet flat on the floor. In space, people must exercise to prevent the heart and other muscles from weakening.

Working in Space

On Earth, the reacting force of friction helps us to do many of our jobs. When we are weightless, jobs consume much more energy. Take the simple problem of opening a hinged floor plate in the Shuttle mid-deck area. If the Shuttle were on Earth, you would simply bend down and pull it open. But if you bent down to do this in space, you would continue in endless somersaults until you managed to stop yourself. You could avoid this problem by using a portable handhold with suction cups.

Astronauts overcome these kinds of difficulties by working together and following carefully detailed plans. Most onboard activities use special items, such as pockets, Velcro strips, suction cups on shoe attachments, and a variety of straps, to counteract the free-floating effect of weightlessness.

TEACHER PRINTOUT

WORKING
LIVING IN SPACE

Objectives

Students will understand the following:

- Gravity is a force that pulls us toward the center of Earth.
- People and objects float around in space because they are weightless.

Vocabulary

Have the students use these words as part of your motivating discussion and in the follow-up *Space Lab* and *Space Countdown* activities.

- gravity (a force that pulls bodies toward the center of Earth)
- weight (the heaviness an object has because of the pull of gravity)
- weightless (having little or no weight because the force of gravity has been balanced by the force of forward speed)
- float

Motivation

1. How much do you weigh?

(Accept any reasonable answers. You might want to bring a metric scale into the classroom and have the children compare their English and metric weights.)

2. Show the class a globe. Explain that people live all over the globe. Ask why people don't fall off the bottom part of our Earth.

(Accept any answers that relate to the gravitational pull of Earth.)

Activity Description

The *Student Liftoff* page for this lesson contains two activities: *Space Lab* and *Space Countdown*.

The *Space Lab* is a hands-on experiment that simulates a feeling of weightlessness. The students are asked: How does it feel to be weightless? This lab simulates weightlessness through an activity involving pressure and relaxation. This activity may be done at school or at home.

The *Space Countdown*, a math activity, requires the students to use addition and subtraction in creating different ways to combine numbers for a total value of ten.

Additional Activities for School or Home

- Read the section of *Mary Poppins* where Mary and the children visit Mary's uncle and end up on the ceiling. Compare this with weightlessness aboard the Space Shuttle.

- Have the students tell about situations where weightlessness is helpful. For example, painting ceilings, wiping away spider webs, reaching packages on the top shelf in supermarkets. Have the students discuss situations where weightlessness is harmful. For example, playing jump rope, running or jogging, trying to drink from a water fountain. After the discusssion, have each student choose any "helpful" or "harmful" situation and draw a picture illustrating their choice.

- Bring in a bathroom scale. Have students bring in objects from home. Suggest the objects be so light that they will not register on the scale.

STUDENT LIFTOFF

What does it mean to be weightless?
It means there is no force pulling you down.
Here on Earth, a force called gravity pulls you down.
Gravity gives you your Earth weight.

In space, there is not enough gravity to pull you down.
You are weightless.
Everything is weightless in space.
Water does not drip down.
It floats up in balls.
Funny things happen in space.

Space Lab

How does it feel to be weightless?

You need: a wall

Step 1. Stand with your side to the wall and your shoulder and arm pressing hard against the wall. Make a fist. Keep your arm straight, and press your fist hard against the wall.

Step 2. Count slowly for ten seconds, 1 and 2 and 3.

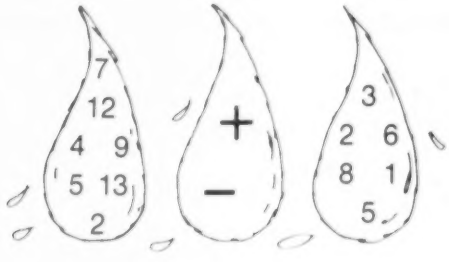
Step 3. Take one sidestep away from the wall. Relax completely. What happens to your arm?

The same thing would happen when your whole body is weightless in space.

Space Countdown

Look at the numbers and signs floating in the pictures of the drops of water. Using only one number or sign from each drop of water, write the different ways to make 10.
For example, 7+3=10.

Can you make up one more example of your own?



TEACHER PRINTOUT

WORKING
LIVING IN SPACE

Objectives

Students will understand the following:

- Gravity is a force that pulls bodies down toward the center of Earth.
- Our bodies are weightless in space because there is not enough gravity.
- The body functions, body measurements, and posture of astronauts are changed by weightlessness.

Vocabulary

Have the students use these words as part of your motivating discusssion and in the follow-up *Space Lab* and *Space Countdown* activities.

- gravity (a force that pulls bodies toward the center of Earth)
- weightless (having little or no weight because the force of gravity has been balanced by the force of forward speed
- centimeters

Motivation

1. **What holds people on both the upper and lower parts of the world? You might want to use a globe to illustrate the Northern and Southern hemispheres of the world.**

(Accept any answers that relate to the force of gravity.)

2. **Have you ever seen pictures of astronauts floating around in space? Why do they float?**

(Accept any answers that relate to the concept of weightlessness, being without the force of gravity.)

3. **What do you think being weightless would do to your body?**

(Accept any reasonable answers.)

Activity Description

The *Student Liftoff* page for this lesson contains two activities: *Space Lab* and *Space Countdown.*

The *Space Lab* is a hands-on experiment that demonstrates how gravity affects objects here on Earth. The students are asked: How can we see the pull of gravity? By increasing the number of marbles in a plastic milk container, they see the increased pull of gravity. This experiment can be done at school or at home.

The *Space Countdown*, a math activity, provides practice in comparing quantities using the symbols that stand for more than $>$, less than $<$, and equal to $=$.

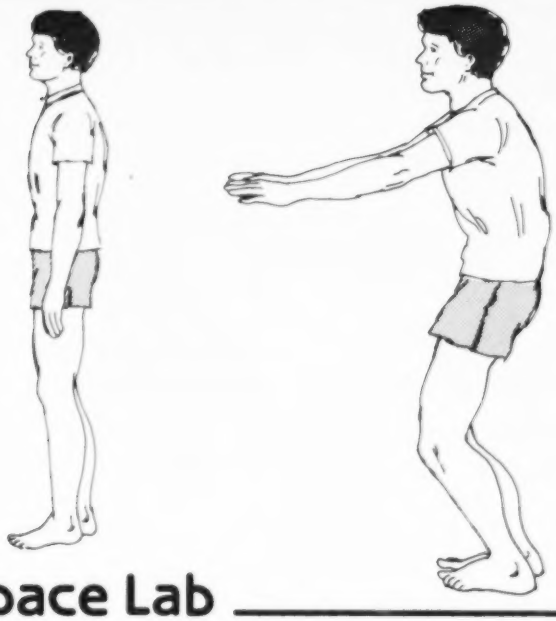
Additional Activities for School or Home

- Have the children jump into the air. Discuss why they come down again. What would happen without gravity? Extend discussion to other objects, such as balls, hats, books.

- Play a true/false game about weightlessness in space. Hold up flash cards with statements written on them. If the statement is true, children simulate floating up. If the statement is false, children slump down in their chairs. You might want to use statements such as the following:

1. Astronauts get more wrinkles.
2. Shoes get loose.
3. Gravity is a force that pulls us up.
4. Astronauts float.
5. Astronauts are two centimeters shorter.
6. Astronauts' arms float in front of them.

STUDENT LIFTOFF



On Earth, we live and work with gravity. Gravity is the force that pulls us down. In space, there is not enough gravity to pull us down.
We are weightless.

Weightlessness changes our bodies. It makes us two to five centimeters taller. Weightlessness makes wrinkles go away, waists get smaller, and shoes get loose.

Weightlessness puts your body in a bent position when you relax. Your arms float in front of you.

Would you like to be weightless?

Space Lab

How can we see the pull of gravity?

You need: 30 marbles, a strong, wide rubber band, scissors, a large plastic milk container.

Step 1. Cut the rubber band open. Tie one end to the handle of the container. Tie the other end of the rubber band to a chalkboard hook.

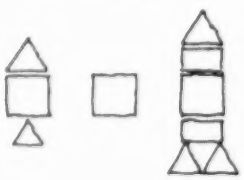
Step 2. Place ten marbles in the container. What happens to the rubber band?

Step 3. Repeat step 2, twice.
Why does the rubber band stretch?
How does this show the pull of gravity?

Space Countdown

Look at the things in each set below. Write the sign that shows more, less, or the same in each box.

> more than
< less than
= equal to or the same



TEACHER PRINTOUT

WORKING LIVING IN SPACE

Objectives

Students will understand the following:

- Astronauts live and work in the weightlessness of space.
- Objects tend to float away from each other in weightlessness.
- Astronauts perform tasks differently under conditions of weightlessness.

Vocabulary

Have the students use these words as part of your motivating discussion and in the follow-up *Space Lab* and *Space Countdown* activities.

- weightlessness (the condition of having no weight)
- suction cups (attachments that hold an astronaut in place)
- floor plate (hinged door that opens into a storage area)
- gravity
- handhold

Motivation

1. Why do you wear sneakers in gym?

(So I don't slip. Because they are comfortable. I can run better. Accept any answers that relate to sneakers giving better traction during physical activity.)

2. What special kind of equipment would mountain climbers need to help them?

(Shoes with cleats that grip the ground. Ropes, belts, and picks to secure them to the face of the mountain.)

3. What kind of special equipment might astronauts need to help them work in space?

(Straps, special suction shoes, handholds to prevent their floating around the cabin.)

Activity Description

The *Student Liftoff* page for this lesson contains two activities: *Space Lab* and *Space Countdown.*

The *Space Lab* is a hands-on experiment that shows how falling objects become weightless. The students are asked: Are falling things weightless? An object becomes weightless because it is falling and is no longer resisting gravity. This experiment may be done at school or at home.

The *Space Countdown,* a math activity, provides practice in reading a number line and in comparing relative distances between objects.

Additional Activities for School or Home

- Ask the children to imagine they are standing on a scale in an elevator. Ask what they think will happen to the weight reading as the elevator goes down. If possible, have the children try this experiment in an elevator. (As the elevator goes down, the weight reading swings back toward zero. The faster the elevator goes, the less it is resisting gravity.)

- Play a game of Space Concentration. Draw two sets of cards, one set with statements and the other set with matching pictures about weightlessness. Spread out the cards face-down. Have the children turn over two cards at a time. If the cards match, the player takes those cards. If they do not match, the cards are turned down and the next player takes a turn. Sample statements can be as follows:

1. Your spoon drifts off the plate.
2. Crumbs float in the air.
3. Jumping rope is an easy way to exercise.
4. Things stay where you put them.
5. Tools float away if not held down.
6. We are weightless on Earth.
7. You are three or more centimeters taller.
8. Gravity is a force that pulls us down.

STUDENT LIFTOFF

In the weightlessness of space, astronauts work differently from the way they work on Earth.

One astronaut trying to tighten a connector to a plug said, "I would get the tool hooked up, and then I would either float loose or the connector floated loose from the plug. I couldn't get everything fixed into place at one time."

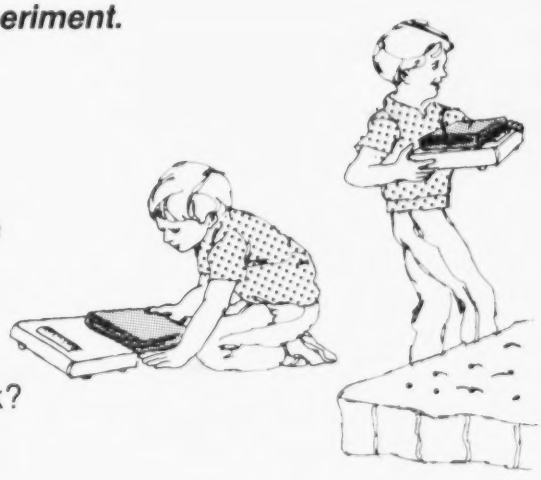
Astronauts must use handholds with suction cups to open a floor plate. Otherwise, when they bend down, they would continue doing somersaults.

Space Lab

You will need an adult to help you with this experiment.

Are falling things weightless?

You need: a heavy book, a bathroom scale, a gym mat or a soft bed



Step 1. Put a heavy book on a bathroom scale. Read the weight. Hold the scale and the book over a gym mat or a soft bed.

Step 2. Watch the numbers on the scale as the book and scale drop onto the bed.
What happens to the weight of the book?
Why does this happen?
How is this like an astronaut in space?

Space Countdown

Astronauts use special equipment to work in the weightlessness of space. Five different kinds of equipment are shown on the number line.

1. How many spaces do you move to get from microgravity shoes to handholds?
2. How many spaces do you move to get from Velcro to suction cups?
3. How many more spaces do you move to get from Velcro to suction cups than from microgravity shoes to handholds?

NASA TEACHER RESOURCE CENTERS

Teacher Resource Centers have been established to provide educators with NASA-related educational materials for use in the classroom. The materials, which can be duplicated at the Centers, include classroom activities, lesson plans, teacher guides, filmstrips, computer software, laser discs, and audio and video tapes.

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